CLAIMS

What is claimed is:

1. An electric-discharge machining apparatus for controlling a machining axis so that a machining average voltage Vg during a predetermined sampling time Ts agrees with a servo standard voltage SV, the apparatus comprising:

an electric power supplying means for supplying electric power between electrodes of a tool electrode and a target to be machined;

an electric-discharge detection means for detecting the waveform of electric discharge generating between the electrodes based on the electric power supplied by the electric power supplying means;

an electric-discharge generation counting means for counting in response to the waveform an electric-discharge generation count Nd during the predetermined sampling time;

a calculating means for calculating an estimation average voltage Vgs between the electrodes based on the electric-discharge generation count; and

an electrode-position controlling means for controlling the machining axis so that the estimation average voltage Vgs calculated by the calculating means agrees with the servo standard voltage SV during the sampling time Ts.

2. An electric-discharge machining apparatus as recited in claim 1, wherein the estimation average voltage Vgs calculated by the calculating means is calculated based on:

$$Vs = V0 - \frac{Nd}{Ts} \times \{Ton \times (V0 - eg) + Toff \times V0\}$$

where Nd is the counted electric-discharge generation count, V0 is a preset unloading voltage, Ton is a pulse width, Toff is a rest time, eg is an electric-discharge voltage, and Ts is the sampling time.

3. An electric-discharge machining apparatus as recited in claim 1, further comprising:

in addition to the electric-discharge generation counting means, a short-circuit generation counting means for counting a short-circuit count N1 of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by the electric power supplying means is lower than a predetermined short-circuit threshold voltage Vsh, wherein calculation of the estimation average voltage Vgs by the calculating means is compensated.

4. An electric-discharge machining apparatus as recited in claim 3, wherein the estimation average voltage Vgs is calculated by:

$$Vgs = V0 - \frac{Nd - N1}{Ts}\{Ton(V0 - eg) + Toff \times V0\} - \frac{N1}{Ts}\{V0 \times (Ton + Toff)\}$$

5. An electric-discharge machining apparatus as recited in claim 1, further comprising, in addition to the electric-discharge generation counting means:

a short-circuit generation counting means for counting a short-circuit count N1 of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by the electric power supplying means is lower than a predetermined short-circuit threshold voltage Vsh;

a small unloading electric-discharge counting means for counting a small unloading electric-discharge count N2 of electric discharge to which the applied voltage supplied by the electric power supplying means changes within a predetermined small unloading time Tdo; and

an abnormal electric-discharge generation counting means for counting an abnormal electric-discharge count N3 of abnormal electric discharge whose voltage reaches a lower value than a predetermined abnormal electric-discharge threshold voltage Vng; wherein:

calculation of the estimation average voltage Vgs by the calculating means is compensated.

6. An electric-discharge machining apparatus as recited in claim 5, wherein the

compensation is performed considering rest-time extension based on the electric-discharge generation other than normal electric-discharge generation.

7. An electric-discharge machining apparatus as recited in claim 6, wherein the estimation average voltage Vgs is calculated by:

$$Vgs = V0 - \frac{Nd - N1}{Ts}\{Ton(V0 - eg) + Toff \times V0\}$$

$$-\frac{N1}{Ts}\{V0(Ton + Toff)\} - \frac{1}{Ts}\{V0(N1 \times Toffs1 + N2 \times Toffs2 + N3 \times Toffs3)\}$$

where Toffs1 is a rest-control time according to the short circuit, Toffs2 is a rest-control time according to the small unloading electric discharge, and Toffs3 is a rest-control time according to the abnormal electric discharge.

8. An electric-discharge machining apparatus as recited in claim 1, further comprising:

in addition to the electric-discharge generation counting means, a small unloading electric-discharge generation counting means for counting a small unloading electric-discharge count N2 of electric discharge to which the applied voltage supplied by the electric power supplying means changes within a predetermined small unloading time Tdo, wherein calculation of the estimation average voltage Vgs by the calculating means is compensated.

9. An electric-discharge machining apparatus as recited in claim 8, wherein the small unloading time Tdo is set to 0.3 - 0.5 times a limited unloading time Tds calculated based on the average current density Id of the electric discharge.

10. An electric-discharge machining method of controlling a machining axis so that a machining average voltage Vg during a predetermined sampling time Ts agrees with a servo standard voltage SV, the method comprising:

a step of detecting the waveform of electric discharge generating, based on supplied electric power, between electrodes of a tool electrode and a target to be

machined;

a step of counting in response to the waveform an electric-discharge generation count Nd during the predetermined sampling time Ts;

a step of calculating an estimation average voltage Vgs between the electrodes, based on the electric-discharge generation count Nd; and

a step of controlling the machining axis so that the estimation average voltage Vgs calculated agrees with the servo standard voltage SV within the sampling time Ts.

11. An electric-discharge machining method as recited in claim 10, wherein the estimation average voltage Vgs is calculated based on:

$$Vs = V0 - \frac{Nd}{Ts} \times \{Ton \times (V0 - eg) + Toff \times V0\}$$

where Nd is the counted electric-discharge generation count, V0 is a preset unloading voltage, Ton is a pulse width, Toff is a rest time, eg is an electric-discharge voltage, and Ts is the sampling time.

12. An electric-discharge machining method as recited in claim 10, wherein the estimation average voltage Vgs is obtained by counting a short-circuit count N1 of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by an electric power supplying means is lower than a predetermined short-circuit threshold voltage Vsh, and by compensating using:

$$Vgs = V0 - \frac{Nd - N1}{Ts}\{Ton(V0 - eg) + Toff \times V0\} - \frac{N1}{Ts}\{V0 \times (Ton + Toff)\}$$

13. An electric-discharge machining method as recited in claim 10, wherein the estimation average voltage Vgs is obtained by counting a short-circuit count N1 of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by an electric power supplying means is lower than a predetermined short-circuit threshold voltage Vsh, a small unloading

electric-discharge count N2 of electric discharge to which the applied voltage supplied by the electric power supplying means changes within a predetermined small unloading time Tdo, and an abnormal electric-discharge count N3 of abnormal electric discharge whose voltage reaches a lower value than a predetermined abnormal electric-discharge threshold voltage Vng, and by using:

$$Vgs = V0 - \frac{Nd - N1}{Ts}\{Ton(V0 - eg) + Toff \times V0\}$$

$$- \frac{N1}{Ts}\{V0(Ton + Toff)\} - \frac{1}{Ts}\{V0(N1 \times Toffs1 + N2 \times Toffs2 + N3 \times Toffs3)\}$$

where Toffs1 is a rest-control time according to the short circuit, Toffs2 is a rest-control time according to the small unloading electric discharge, and Toffs3 is a rest-control time according to the abnormal electric discharge.